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Wolfe et al.

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(54) **METHOD AND SYSTEM FOR ADAPTIVE TRANSCODING AND TRANSRATING IN A VIDEO NETWORK**

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H04N 21/2343	(2011.01)
H04N 21/238	(2011.01)

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(58) **Field of Classification Search**

None

See application file for complete search history.

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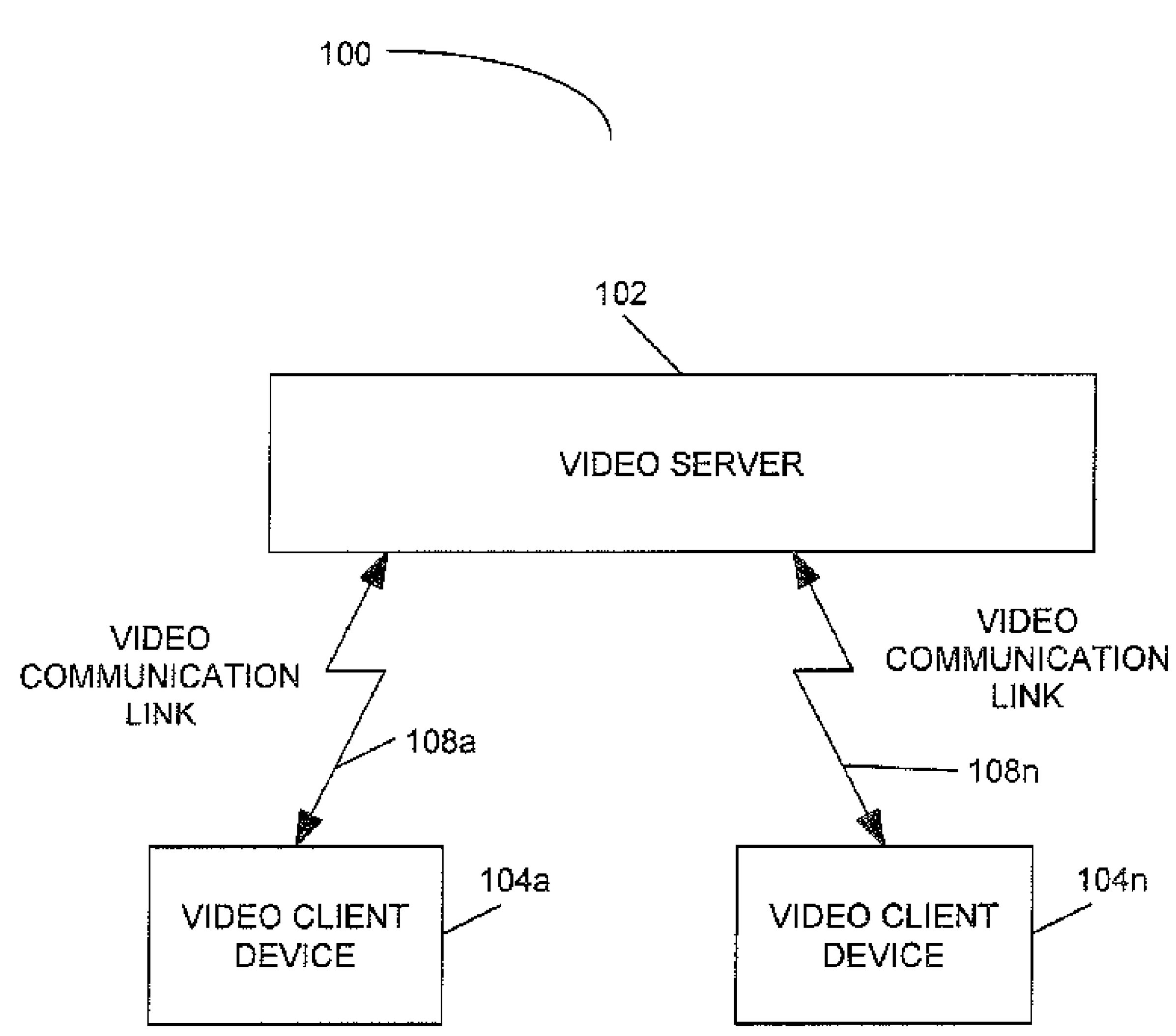
Primary Examiner — Cai Chen

(57) **ABSTRACT**

A video server adaptively selects an appropriate video encoding standard and an appropriate video encoding rate for encoding video content to be downloaded to one or more video client devices over a communication network. The video server adaptively selects the video encoding standard and the video encoding rate based upon factors such as the data transmission rate of the communication network, the processing speed of the video client device, or the type of the video content to be downloaded. Once the video encoding standard and the video encoding rate are selected, video content can be transcoded prior to downloading to one or more video client devices. During the download, the video content may be adaptively transrated, such as in response to a change in the data transmission rate of the communication network.

18 Claims, 8 Drawing Sheets



(51) **Int. Cl.**
H04N 21/2662 (2011.01)
H04N 21/4363 (2011.01)
H04N 21/4402 (2011.01)
H04N 21/61 (2011.01)

(52) **U.S. Cl.**
CPC . ***H04N 21/43637*** (2013.01); ***H04N 21/440218*** (2013.01); ***H04N 21/6131*** (2013.01)

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JPO communication dated Feb. 10, 2009 in Japanese Patent Application No. 2006-526967 filed Sep. 13, 2004.

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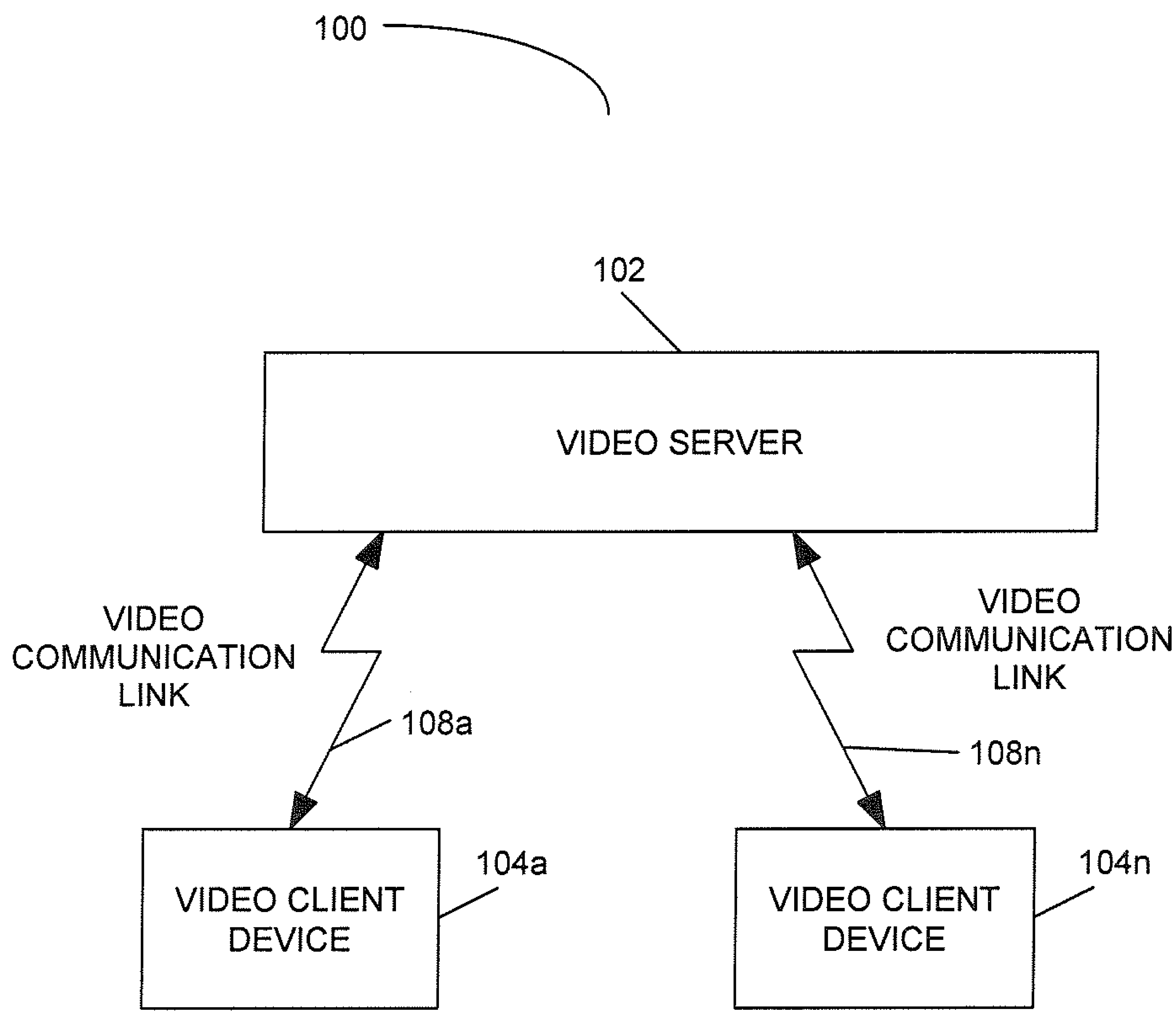
100
102
VIDEO SERVER
VIDEO
COMMUNICATION
LINK
108a
VIDEO
COMMUNICATION
LINK
108n
104a
VIDEO CLIENT
DEVICE
104n
VIDEO CLIENT
DEVICE

FIG. 1

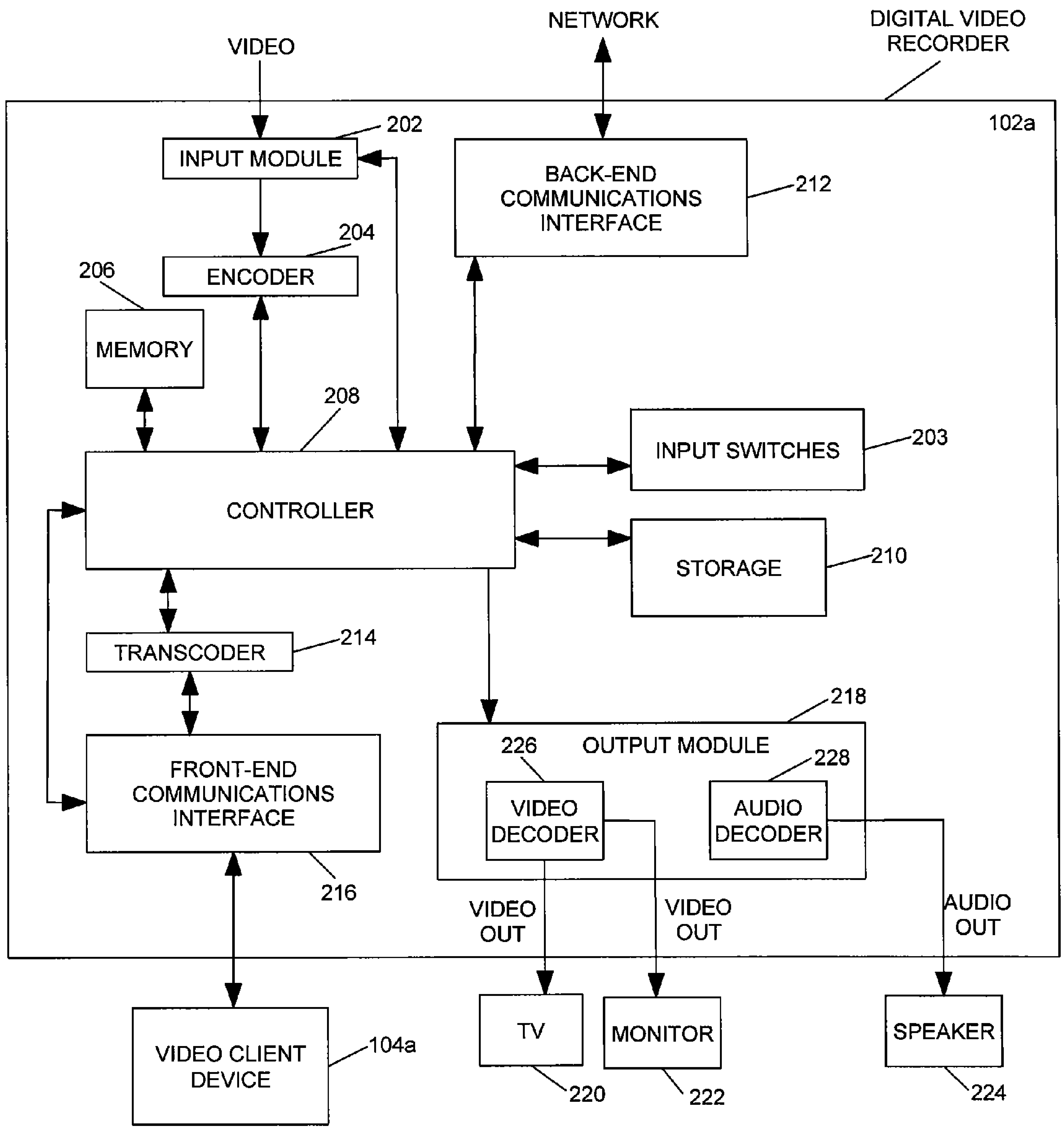
VIDEO
NETWORK
DIGITAL VIDEO RECORDER
102a
INPUT MODULE
202
BACK-END COMMUNICATIONS INTERFACE
212
ENCODER
204
206
MEMORY
208
INPUT SWITCHES
203
CONTROLLER
STORAGE
210
TRANSCODER
214
218
FRONT-END COMMUNICATIONS INTERFACE
226
OUTPUT MODULE
228
VIDEO DECODER
AUDIO DECODER
216
VIDEO OUT
VIDEO OUT
AUDIO OUT
VIDEO CLIENT DEVICE
104a
TV
MONITOR
SPEAKER
220
222
224

FIG. 2

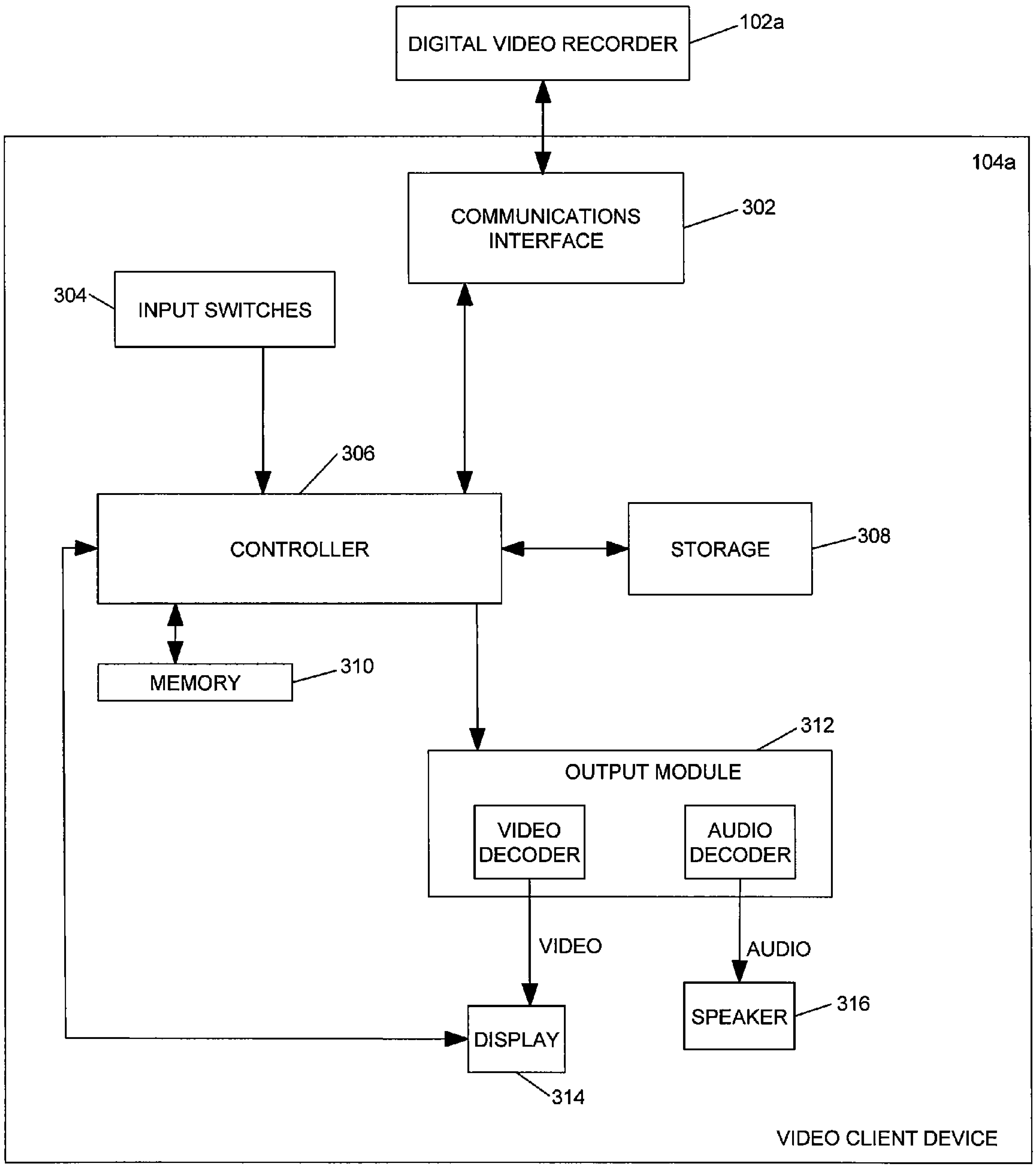
DIGITAL VIDEO RECORDER
102a
104a
COMMUNICATIONS INTERFACE
302
304
INPUT SWITCHES
306
CONTROLLER
STORAGE
308
MEMORY
310
312
OUTPUT MODULE
VIDEO DECODER
AUDIO DECODER
VIDEO
AUDIO
SPEAKER
316
DISPLAY
314
VIDEO CLIENT DEVICE

FIG. 3A

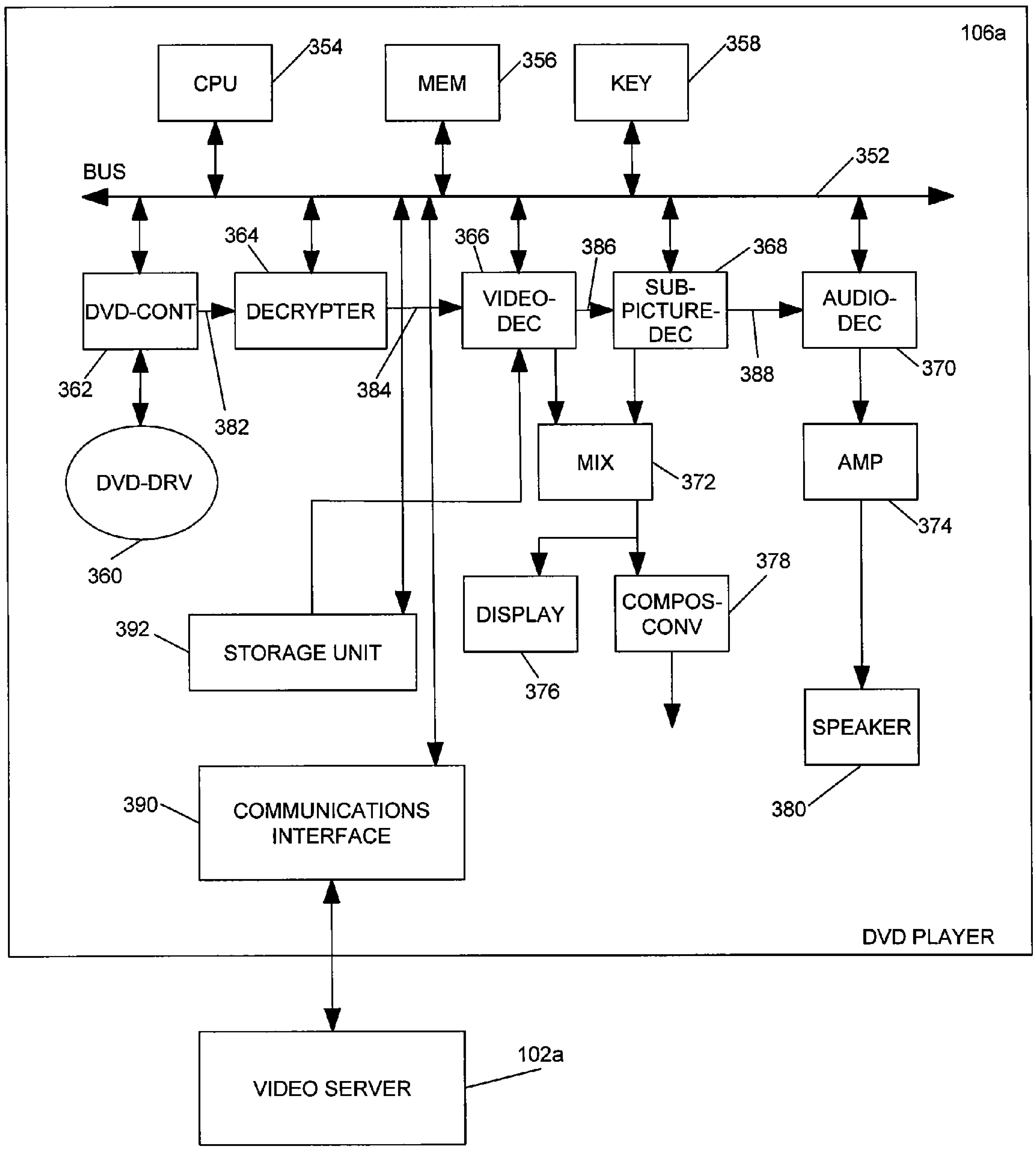
106a
CPU
354
MEM
356
KEY
358
BUS
352
364
366
386
368
DVD-CONT
DECRYPTER
VIDEO-DEC
SUB-PICTURE-DEC
AUDIO-DEC
362
382
384
388
370
DVD-DRV
MIX
372
AMP
374
360
378
DISPLAY
COMPOS-CONV
392
STORAGE UNIT
376
SPEAKER
390
COMMUNICATIONS INTERFACE
380
DVD PLAYER
VIDEO SERVER
102a

FIG. 3B

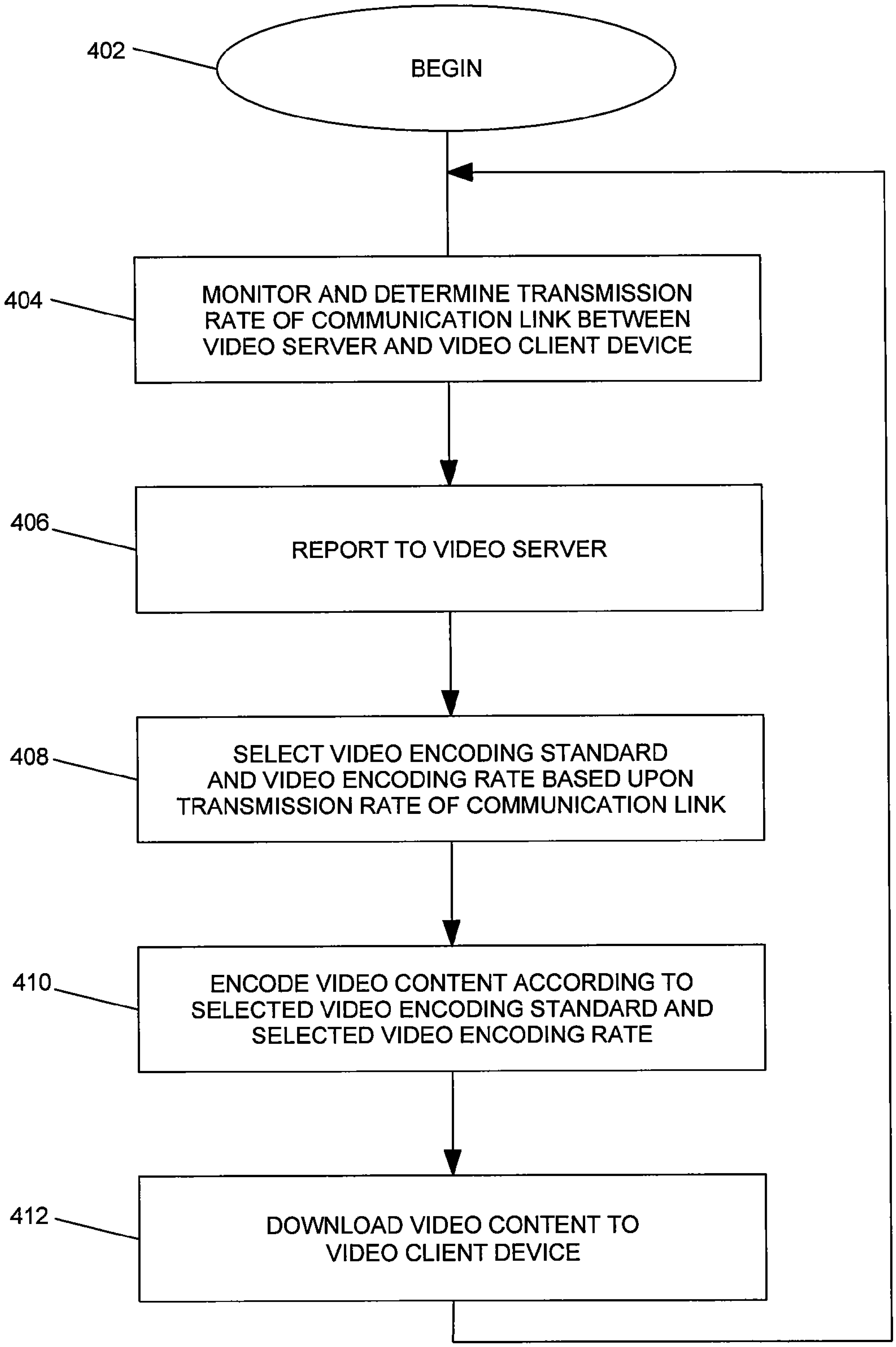
402
BEGIN
404
MONITOR AND DETERMINE TRANSMISSION RATE OF COMMUNICATION LINK BETWEEN VIDEO SERVER AND VIDEO CLIENT DEVICE
406
REPORT TO VIDEO SERVER
408
SELECT VIDEO ENCODING STANDARD AND VIDEO ENCODING RATE BASED UPON TRANSMISSION RATE OF COMMUNICATION LINK
410
ENCODE VIDEO CONTENT ACCORDING TO SELECTED VIDEO ENCODING STANDARD AND SELECTED VIDEO ENCODING RATE
412
DOWNLOAD VIDEO CONTENT TO VIDEO CLIENT DEVICE

FIG. 4

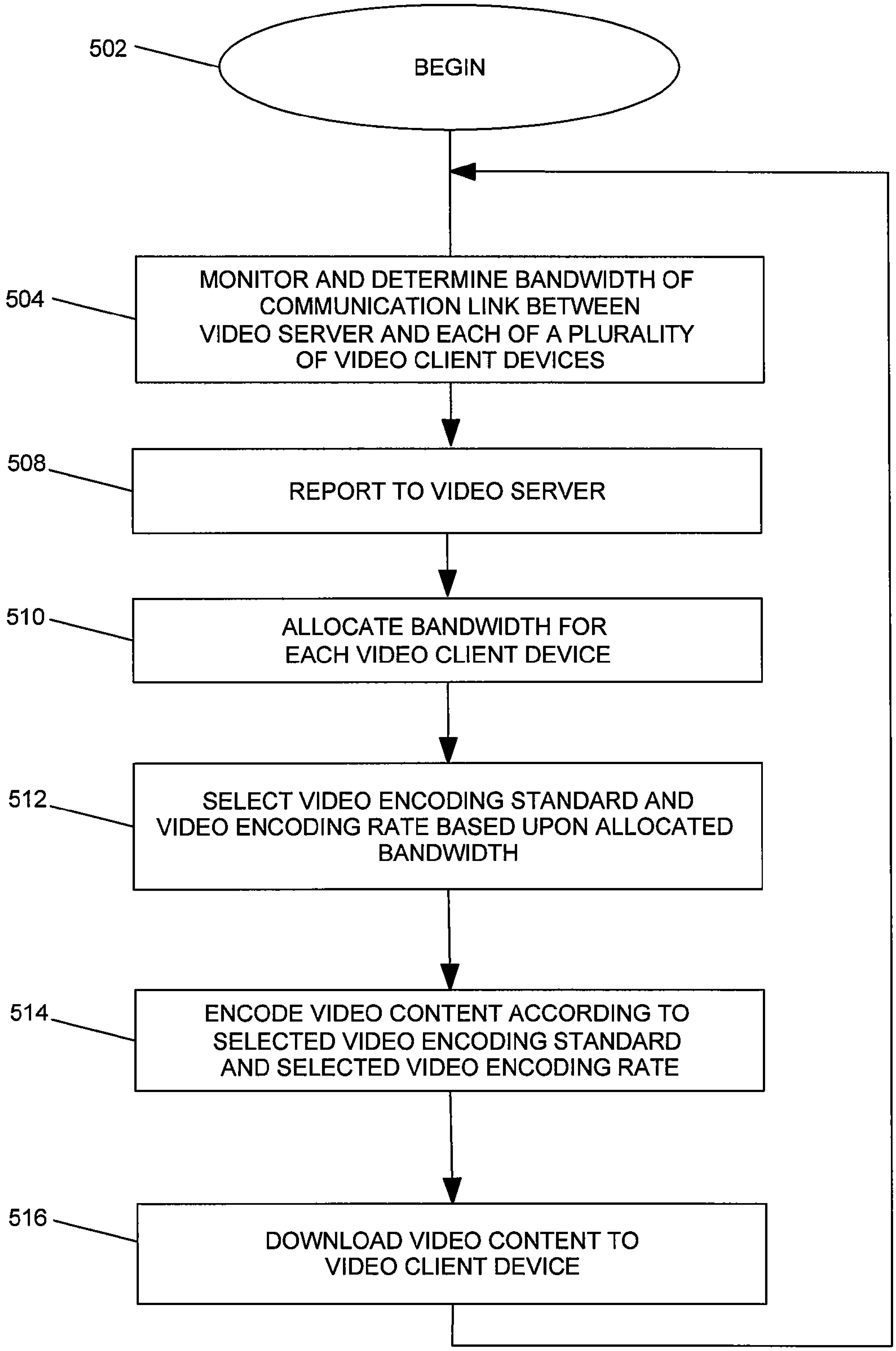
502
BEGIN
504
MONITOR AND DETERMINE BANDWIDTH OF COMMUNICATION LINK BETWEEN VIDEO SERVER AND EACH OF A PLURALITY OF VIDEO CLIENT DEVICES
508
REPORT TO VIDEO SERVER
510
ALLOCATE BANDWIDTH FOR EACH VIDEO CLIENT DEVICE
512
SELECT VIDEO ENCODING STANDARD AND VIDEO ENCODING RATE BASED UPON ALLOCATED BANDWIDTH
514
ENCODE VIDEO CONTENT ACCORDING TO SELECTED VIDEO ENCODING STANDARD AND SELECTED VIDEO ENCODING RATE
516
DOWNLOAD VIDEO CONTENT TO VIDEO CLIENT DEVICE

FIG. 5

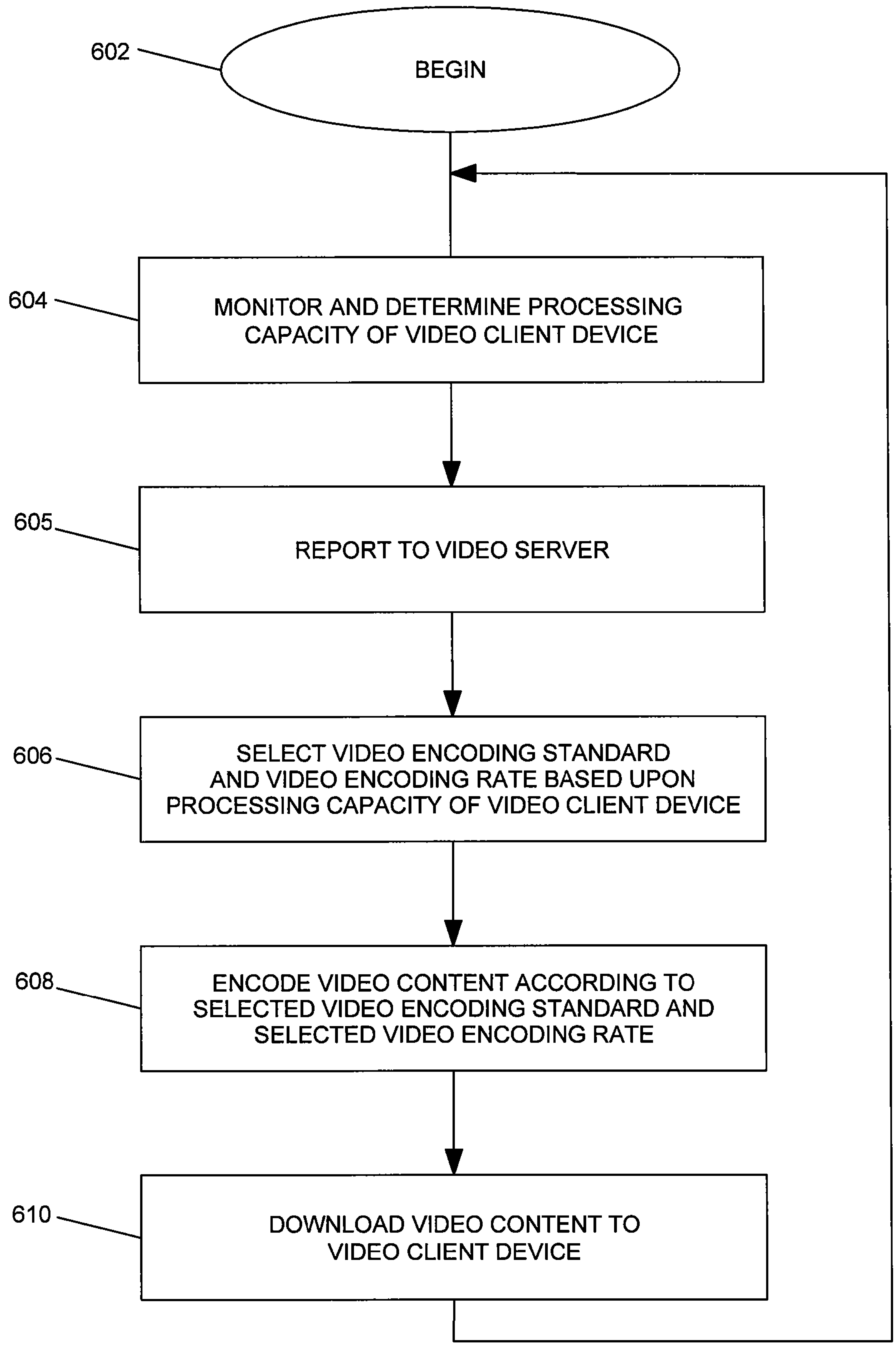
602
BEGIN
604
MONITOR AND DETERMINE PROCESSING CAPACITY OF VIDEO CLIENT DEVICE
605
REPORT TO VIDEO SERVER
606
SELECT VIDEO ENCODING STANDARD AND VIDEO ENCODING RATE BASED UPON PROCESSING CAPACITY OF VIDEO CLIENT DEVICE
608
ENCODE VIDEO CONTENT ACCORDING TO SELECTED VIDEO ENCODING STANDARD AND SELECTED VIDEO ENCODING RATE
610
DOWNLOAD VIDEO CONTENT TO VIDEO CLIENT DEVICE

FIG. 6

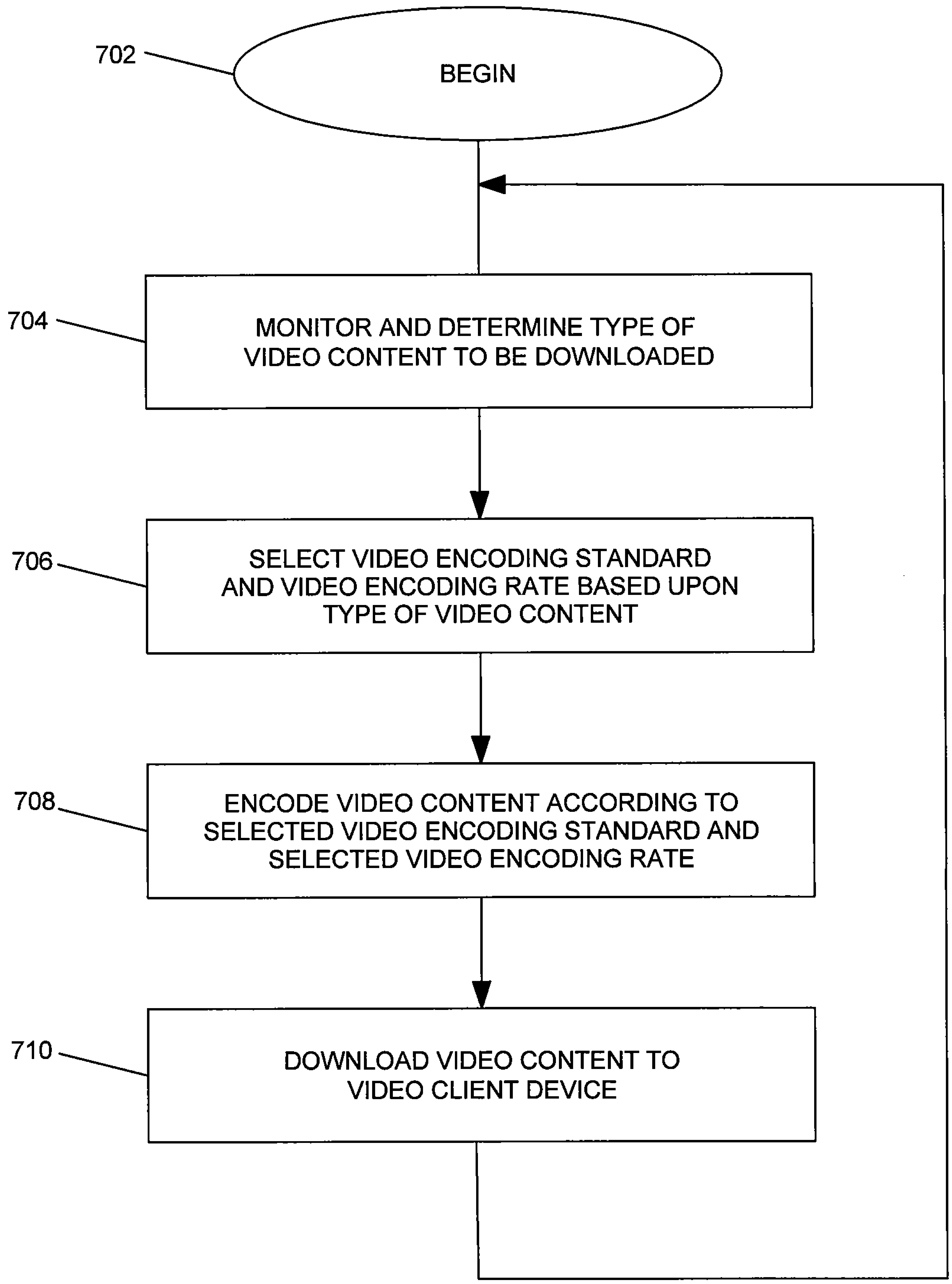
702
BEGIN
704
MONITOR AND DETERMINE TYPE OF VIDEO CONTENT TO BE DOWNLOADED
706
SELECT VIDEO ENCODING STANDARD AND VIDEO ENCODING RATE BASED UPON TYPE OF VIDEO CONTENT
708
ENCODE VIDEO CONTENT ACCORDING TO SELECTED VIDEO ENCODING STANDARD AND SELECTED VIDEO ENCODING RATE
710
DOWNLOAD VIDEO CONTENT TO VIDEO CLIENT DEVICE

FIG. 7

METHOD AND SYSTEM FOR ADAPTIVE TRANSCODING AND TRANSRATING IN A VIDEO NETWORK

RELATED APPLICATION

This application claims the benefit of U.S. Provisional Application No. 60/503,151, filed on Sep. 15, 2003, which is incorporated by reference herein.

FIELD OF THE INVENTION

The present invention relates generally to video networks. More specifically, it relates to altering encoding formats and encoding rates of video content transmitted in a video network.

BACKGROUND OF THE INVENTION

Digital entertainment systems such as digital video recorders (DVRs), personal video recorders (PVRs), and digital video disc (DVD) players have received increased attention lately and have become popular. These digital entertainment systems are capable of reproducing video and/or audio content at a higher quality compared to conventional analog entertainment systems because the video and audio content are stored in digital format. The digital format of video content also facilitates implementation of program guides and manipulation of the video content by users.

Conventional DVRs typically receive video content either from a conventional video cable or through broadband connection, and encode and store the received video content in compressed digital formats such as MPEG-2 for future retrieval by a user. In this manner, users are able to view high quality video content at any desired time without deterioration of image quality as compared with analog recording of video content. One example of a conventional DVR is the ReplayTV® brand of DVRs.

Communications networks have a certain transmission rate in a given frequency band. For example, the IEEE 802.11a standard provides up to 54 Mbps transmission in the 5 GHz band. The IEEE 802.11b standard (also referred to as 802.11 High Rate or Wi-Fi) provides 11 Mbps transmission (with a fallback to 5.5 Mbps, 2 Mbps and 1 Mbps) in the 2.4 GHz band. The IEEE 802.11g standard provides 20+Mbps in the 2.4 GHz band. The Bluetooth standard provides up to 720 Kbps data transfer in the 2.4 GHz band. As such, different video client devices in a video network may use different communications standards. Furthermore, the data transmission rate of the communication network between a video server and the video client devices may be affected by external conditions such as noise and the like. As such, these various communication networks can only handle video encoding standards and video encoding rates using a transmission rate lower than that of the video client device.

Furthermore, digital video encoding standards require a certain amount of bandwidth. For example, MPEG-1 uses a bandwidth ranging from 500 Kbps to 4 Mbps, averaging about 1.25 Mbps. MPEG-2 uses a bandwidth ranging from 4 to 16 Mbps. Bandwidths are typically dependent on source quality in addition to encoding technology. For example, MPEG-2 is generally more efficient than MPEG-1, but the official standards define their respective bit rates. That is, if desired, MPEG-1 could be run at a much higher bit rate than 4 Mb/sec. For the same bit rates, different encoding formats

may have different source qualities. For example, at the same bit rate, MPEG-2 will generally have a higher source quality than MPEG-1.

In addition, video client devices may have limited processing speed depending upon the type of processors and memories they use. As such, the video client devices may be able to handle only certain types of video encoding standards and video encoding rates requiring a processing speed that is lower than the maximum processing speed supported by the video client devices. Also, the video client devices might also be limited by the particular codecs that they support. For example, a video client device that does not include an MPEG-1 codec might not be able to playback MPEG-1 video content no matter how much processing speed the video client device supports.

Furthermore, certain types of video content may require higher a transmission rate in communications between the video server and the video client devices than other types of video content. For example, animation video contents would require higher data transmission rates for downloading because it requires a relatively high encoding rate in order to deliver good quality images. On the other hand, a concert recording would not require such high data transmission rates, because it does not require high encoding rates to deliver acceptable quality images of a concert scene.

Therefore, there exists a need for an improved method of transmitting video content between a video server and a video client device.

SUMMARY OF INVENTION

The present invention provides adaptive transcoding and transrating capabilities in a video network when downloading video content to client video devices over a communication network, such as by adaptively selecting an appropriate video encoding standard and/or video encoding rate based upon factors such as the transmission rate of the communication network, the processing speed of the video client device(s) and the video content. The video content can then be transcoded to the selected encoding standard and/or encoding rate prior to downloading to a video device. When one or more of these factors are changed, then the video encoding standard and/or the video encoding rate may be adaptively changed. For example, during a download to a video device, the downloaded content might be transrated in order to account for network congestion or other factors altering the transmission rate of the communication network.

In one embodiment, a video server monitors the transmission rate of a communication link between the video server and the video client device and adaptively selects an appropriate video encoding standard and/or video encoding rate based upon the transmission rate of the communication network and based on the codecs supported by the video client device. In another embodiment, the video server monitors the bandwidth of a video network including a video server and a plurality of video client devices, adaptively allocates parts of the bandwidth to each of the video client devices, and encodes video content using encoding standards and/or encoding rates based upon the allocated bandwidth for downloading to the video client devices and based on the codecs supported by the video client devices.

In still another embodiment, the video server determines the rate at which the video client device can receive data and selects an appropriate video encoding standard and/or video encoding rate based upon the transmission rate for downloading to the video client device. The video server can also determine the video content to be downloaded to a video client device and an acceptable error rate for the video content and selects an appropriate video encoding standard and/or video encoding rate based upon the video content.

Because the video server may adaptively select an appropriate video encoding standard and/or video encoding rate for downloading video content to video client device(s) based upon factors such as the data transmission rate of the communication link, the processing speed of the video client device(s), or the video content, the video server may download video content to the video client device(s) over the video network in manner that takes advantage of the available resources while still using a supported encoding standard and encoding rate.

BRIEF DESCRIPTION OF THE DRAWINGS

The teachings of the present invention can be readily understood by considering the following detailed description in conjunction with the accompanying drawings.

FIG. **1** is a block diagram illustrating a video network including a video server and video client devices according to an embodiment of the present invention.

FIG. **2** is a block diagram illustrating a digital video recorder according to an embodiment of the present invention for use in a video network.

FIG. **3**A is a block diagram illustrating a video client device according to an embodiment of the present invention for use in a video network.

FIG. **3**B is a block diagram illustrating a video client device according to another embodiment of the present invention for use in a video network.

FIG. **4** is a flowchart illustrating a method of selecting a video encoding standard and a video encoding rate according to a first embodiment of the present invention.

FIG. **5** is a flowchart illustrating a method of selecting a video encoding standard and a video encoding rate according to a second embodiment of the present invention.

FIG. **6** is a flowchart illustrating a method of selecting a video encoding standard and a video encoding rate according to a third embodiment of the present invention.

FIG. **7** is a flowchart illustrating a method of selecting a video encoding standard and a video encoding rate according to a fourth embodiment of the present invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

The preferred embodiments of the present invention will be described below with reference to the accompanying drawings.

FIG. **1** is a block diagram illustrating a video network **100** according to an embodiment of the present invention. The video network **100** includes a video server **102** and one or more video client devices **104***a*, **104***n*. Although FIG. **1** is shown to have two video client devices **104***a*, **104***n*, the video network **100** can have any number of video client devices.

Referring to FIG. **1**, the video server **102** stores video content in a digital format, such as MPEG-1, MPEG-2, MPEG-4, DivX, Windows Media Audio ("WMA") or others. The video server **102** can transmit the video content to the video client devices **104***a*, **104***n* via respective video communication links **108***a*, **108***n*. Before transmitting the video content to the video client devices **104***a*, **104***n*, the video server **102** might first transcode the video content into a different encoding standard and/or video encoding rate. The video server **102** may then transmit the transcoded video content to the video client devices **104***a*, **104***n* via the respective video communication links **108***a*, **108***n*. As illustrated in FIG. **1**, wireless communication links **108***a*, **108***n* are preferably used between the video server **102** and the video client devices **104***a*, **104***n* However, it should be noted that wired communication links might also be used.

The transmission rate of the video communication link **108***a* between the video server **102** and the video client device **104***a* may be different from the transmission rate of the video communication link **108***n* between the video server **102** and the other client device **104***n*. Thus, the video server **102** may separately monitor and determine the respective transmission rates of the communication links **108***a*, **108***n* between the video server **102** and the video client devices **104***a*, **104***n*. Then, the video server **102** might adaptively select an appropriate video encoding standard and/or an appropriate video encoding rate based upon the transmission rate of the communication links **108***a*, **108***n* and based on the codecs supported by the video client devices **104***a*, **104***n*. This can allow the video content to be downloaded to the video client devices **104***a*, **104***n* in a manner that takes advantage of the transmission rates supported by the communication links **108***a*, **108***n* so as to maximize the image quality of the video content.

The video server **102** can be any type of digital device that can store video content in digital format and transcode video content according to a plurality of video encoding standards and/or video encoding rates. The video server **102** also preferably has wireless communication capabilities for downloading video content to video client devices **104***a*, **104***n* although the video server **102** can also have wired communication capabilities instead of wireless communication capabilities. For example, the video server **102** might be a digital video recorder, such as the ReplayTV® brand of digital video recorders, with wireless communication capabilities and other functionality of the present invention added to it.

The video client devices **104***a*, **104***n* can also be any type of digital device that can receive video content in digital format over a communication network. The video content is downloaded from the video server **102** to the video client devices **104***a*, **104***n* according to various video encoding standards and/or video encoding rates. The video client devices **104***a*, **104***n* preferably have wireless communication capabilities for receiving video content in digital format from the video server **102**, although the video client devices **104***a*, **104***n* might also have wired communication capabilities. Examples of the video client devices **104***a*, **104***n* are digital video recorders with wireless communication capabilities and decoding capabilities added to them.

The video client devices **104***a*, **104***n* might optionally include storage (e.g., hard disks or other such memory) for storing the received content. The storage can allow the video client devices **104***a*, **104***n* to store the received content for later playback; however, a video client device with storage would not necessarily have to store downloaded video content. Video client devices without storage might only be able to playback video content in real-time or near real-time as it is downloaded to the devices but not otherwise store the video content for future playback. Even video client devices without sufficient storage for storing large amounts of downloaded video content might still include a small amount of memory for buffering the downloaded video content prior to playing it back on the video client device.

FIG. **2** is a block diagram illustrating a digital video recorder **102***a* as an example of a video server **102** according to one embodiment of the present invention. Referring to FIG. **2**, the digital video recorder **102***a* includes an input module **202**, input switches **203**, an encoder **204**, a memory **206**, a controller **208**, a data storage unit **210**, a back-end communications interface **212**, a transcoder **214**, a front-end communications interface **216**, and an output module **218**. The digital video recorder **102***a* is coupled to a TV **220**, a monitor **222**, a speaker **224**, and a video client device **104***a*. While the digital video recorder **102***a* is shown coupled to multiple output devices, the digital video recorder **102***a* need only be coupled to a single output device.

The input module **202** may receive input video content through various conventional interfaces, including coaxial RF antennas, an S-Video interface, and others. The received video signals may originate from a standard NTSC broadcast, high definition television (HDTV) broadcast, standard cable, satellite, home video (e.g., VHS) or other sources. The input module **202** may also receive input from other devices, such as set top box that receives one signal format and outputs an NTSC signal or other conventional video format. The input module **202** is configured to include appropriate tuning functionality.

The video content received by the input module **202** is passed on to the encoder **204**. The encoder **204** converts video signals from a first format (e.g., analog NTSC, VHS, S-Video, or other conventional format) to a digital format, such as an MPEG format. Other digital formats may alternatively be used. The digital video data is then stored in the storage unit **210** for future retrieval under control of the controller **208**.

The storage unit **210** may be any type of rewritable memory capable of storing digital data, such as a hard disk, an optical disk (e.g., a rewritable DVD (DVD-RW), rewritable CD (CD-RW), etc. . . .), flash memory, network storage or the like. Although various capacities of the storage unit **210** may be provided ranging from a few minutes to hundreds of hours, the storage unit **210** preferably stores at least one hour of video content in digital format. Currently, roughly about 1 hour of video content is stored using standard image quality for each gigabyte of storage. Video content stored in the storage unit **210** may be viewed immediately or at a later time. Additional information such as program guide data, title of the video content, and the like may be stored in the storage unit **210** in association with the stored video content to identify and manage the stored video content.

The digital video recorder **102***a* may also be connected to a data communication network, such as the Internet, via the back-end communications interface **212**. The back-end communications interface **212** is a standard network interface that allows connection to an Ethernet-based network. This back-end communications interface **212** may also be used to connect to a home network or to a broadband Internet network. The digital video recorder **102***a* may download video content in digital format through the back-end communication interface **212** from various video content sources on the Internet. Because the video content received through the back-end communication interface **212** is generally already in digital format, the controller **208** might store the content in the storage medium **210** without processing by the encoder **204**.

In addition, the digital video recorder **102***a* can transmit data to a remote server (not shown) on the data communication network through the back-end communications interface **212**. For example, pay-per-view content selection information, request of specific entertainment content, credit card payment information, or any other type of information used by the digital video recorder **102***a* can be transmitted via the back-end communication interface **212** to the remote server.

The controller **208** controls the operation of the various components in the digital video recorder **102***a*, including the input module **202**, the encoder **204**, the memory **206**, the back-end communications interface **212**, the storage unit **210**, the transcoder **214**, the front-end communications interface **216**, and the output module **218**. To this end, the controller **208** executes instructions or programs stored in the memory **206** to provide various functionalities of the digital video recorder **102***a*, such as monitoring and determining the data transmission rate of the communication network between the digital video recorder **102***a* and the video client device **250** and selecting an appropriate video encoding standard and/or video encoding rate based upon the data transmission rate of the communication network. The memory **206** operates as a working memory for the controller **208** when the controller executes instructions and programs and may store additional instructions such as boot-up sequences or other information. The memory **206** is preferably a rewritable memory such as an SRAM or DRAM. Read-only memory, such as ROM, or other types of memory might also be used.

The output module **218** includes a video decoder **226** and an audio decoder **228**. The video decoder **226** and the audio decoder **228** are commonly MPEG decoders that convert the digital video and digital audio content stored in the storage medium **210** into a format compatible with conventional display device, such as an NTSC format television set **220** or a computer monitor **222**, and with conventional speakers **224**. Other types of encoders and decoders, such as DivX, WMA or others, might alternatively be used.

The digital video recorder **102***a* downloads video content stored in the storage unit **210** to the video client device **104***a* via the front-end communications interface **216**. The front-end communications interface **216** is preferably a wireless communication interface, such as a cellular modem, a Bluetooth interface, satellite communication interface, RF communication interface, or the like. Alternatively, a wired communication interfaces might be used. Any wireless communication standard can be used with the front-end communications interface **216**, including the various IEEE 802.11 standards, Bluetooth and others. Also, the available bandwidth on such wireless communication networks varies widely depending upon the condition of the wireless communication networks. Alternatively, the video content can be downloaded to the video client device **104***a* with wired communication capabilities. In such case, the front-end communications interface **216** is a wired communication interface such as a standard modem that can be connected to a regular telephone line, an RS-232C interface, a standard USB port, an IEEE 1394 connection (otherwise known as FireWire, i.Link, or Lynx) or the like.

In one embodiment, the controller **208** controls the front-end communications interface **216** to monitor and determine the data transmission rate of the communication link between the digital video recorder **102***a* and the video client device **104***a*. The digital video recorder **102***a* can also communicate with the video client devices **104***a*, **104***n* to determine the particular codecs supported by the video client devices **104***a*, **104***n*. In making subsequent determinations of the video encoding standards and/or video encoding rates to use when downloading video content to the video client devices **104***a*, **104***n*, the digital video recorder **102***a* can also take into account the codecs supported by the video client devices **104***a*, **104***n*. This can help ensure that a video client device **104***a*, **104***n* receives the video content in a format that can be played back on the video client device **104***a*, **104***n*.

Once the data transmission rate of the communication network is determined, the controller **208** selects a video encoding standard and video encoding rate appropriate for the transmission rate of the communication channel. For example, if the communication network supports a maximum data rate of 2 Mbps, then an MPEG-2 encoding standard would not be appropriate for use with the communication network since MPEG-2 requires a 4-16 Mbps transmission rate. In such case, the controller **208** might select the best encoding standard compatible with 2 Mbps transmission, such as MPEG-1 which typically requires 1.25 Mbps. On the other hand, if the communication network uses IEEE 802.11a (e.g., 54 Mbps), then the controller **208** might select the best encoding standard and the best encoding rate compatible with 54 Mbps transmission, such as MPEG-2 with a 16 Mbps transmission rate. As another example, if the communication network uses IEEE 802.11b (e.g., 11 Mbps), then the controller **208** might select the best encoding standard and the best encoding rate compatible with a 11 Mbps transmission rate, such as MPEG-2 using an 11 Mbps transmission rate. It should be noted that the particular video encoding standards and the encoding rates given above are mere examples. Thus, the controller **208** can select a higher or lower quality video encoding standard and/or video encoding rate as long as the video encoding standard and the video encoding rate are compatible with the determined data transmission rate of the communication network.

In another embodiment, the controller **208** allocates bandwidth among a plurality of video client devices **104***a*. Although FIG. **2** shows one video client device **104***a*, the front-end communications interface **216** of the digital video recorder **102***a* is capable of communicating with a plurality of video client devices **104***a*-**104***n* according to different communication standards under control of the controller **208**. In such case, the digital video recorder **102***a* allocates part of the bandwidth to each of the video client devices **104***a*-**104***n*. For example, if the digital video recorder **102***a* communicates with two video client devices **104***a*, **104***n* using IEEE 802.11b (e.g., 11 Mbps), the controller **208** might allocate half the bandwidth (e.g., 5.5 Mbps) to each of the two client video devices **104** and select a video encoding standard and/or video encoding rate compatible with the allocated bandwidth. As such, the controller **208** might select MPEG-1 with the highest encoding rate (e.g., 4 Mbps) or MPEG-2 with an encoding rate lower than 5.5 Mbps, thereby allowing simultaneous communication with both client video devices. The selected video encoding standards and/or video encoding rates might also be dependent on the client's capacity, buffer size, processing speed, etc. Alternatively, the controller **208** might use unequal bandwidth allocations, which might cause different video encoding standards and/or video encoding rates to be used between the devices.

In still another embodiment, the controller **208** detects the processing speed of a plurality of video client devices **104***a*-**104***n* to which video content is downloaded and selects a video encoding standard and/or video encoding rate compatible with the processing speed of the video client devices **104***a*-**104***n*. In still another embodiment, the video client devices **104***a*-**104***n* might report their processing speeds to the digital video recorder **102***a*. If the video client device **104***a*-**104***n* does not have the processing speed to decode video content encoded at encoding rates higher than 2 Mbps, the controller **208** selects a video encoding standard and an encoding rate that the video client devices **104***a*-**104***n* can handle. On the other hand, if the client device **250** has the processing speed to decode video content encoded at encoding rates of up to 16 Mbps, the controller **208** may select MPEG-2 that typically encodes video content at rates of 4-16 Mbps.

In still another embodiment, the controller **208** selects the video encoding standard and the video encoding rate based upon the video content to be downloaded. For example, if the digital video recorder **102***a* needs to download video content that requires high-quality images such as animation, the controller **208** selects a video encoding standard and video encoding rate that delivers higher quality images. On the other hand, if the digital recorder **102***a* downloads video content that does not require high-quality images, such as recordings of concerts, the controller **208** selects a lower quality video encoding standard and video encoding rate that can deliver acceptable quality images. In this manner, the digital video recorder **102***a* can save bandwidth when dealing with a plurality of video client devices **104***a*-**104***n*.

Once the controller **208** selects the video encoding standard and the video encoding rate based upon one or more of the factors described above, the transcoder **214** transcodes the video content stored in the storage unit **210** under control of the controller **208** according to the selected video encoding standard and selected video encoding rate. That is, the controller **208** may convert the video content from one compressed digital format to another compressed digital format. In transcoding the video content, the controller **208** may first decode the video content and then re-encode the video content to the new standard and/or encoding rate. For example, the controller **208** might decode the video content from a compressed form to an uncompressed form and then re-encode the video content into a different compressed form. Alternatively, the controller **208** might convert the video content from one digital format to another digital format without requiring a decoding phase. The transcoded video content may then be downloaded to the video client devices **104***a*-**104***n* via the front-end communications interface **216**.

Once the digital video recorder **102***a* determines a video encoding standard and video encoding rate, it can start downloading the video content to the video client devices **104***a*, **104***n*. During the download, however, various factors that influenced the original selection of the video encoding standard and/or video encoding rate may change. For example, network congestion might cause the data transmission rate of the communication network to decrease. Alternatively, the communication network might become less congested and therefore its data transmission rate might increase. Alternatively, the video client devices **104***a*, **104***n* might report different processing speeds back to the digital video recorder **102***a*. Other factors might change as well.

The digital video recorder **102***a* can monitor for these various changes and use them as a basis for further varying the video encoding standard and/or video encoding rate. For example, in response to detecting that the data transmission rate of the communication network has increased or decreased, the digital video recorder **102***a* may transrate the video content being downloaded to the video client devices **104***a*, **104***n*. Transrating generally involves changing the video content so as to alter the underlying encoding rate (e.g., either increasing or decreasing the encoding rate) of the video content. This would generally also alter the data transmission rate at which the video content needs to be downloaded to the video client devices **104***a*, **104***n* in order to support real-time playback of the video content. For example, video content that is transrated to a lower encoding rate could then be downloaded at a lower data transmission rate while still allowing the video client device **104***a*, **104***n* to still support real-time playback of the video content. It is possible that the transrated video content still might not be downloaded to the video client devices **104***a*, **104***n* at a fast enough rate to support real-time playback, however, transrating the video content to reduce its underlying encoding rate might still decrease the overall delays in downloading and playing back the video content that would otherwise occur of the video content were not transrated. Thus, transrating involves more than simply increasing or decreasing the rate at which the video is downloaded to the video client devices **104***a*, **104***n*.

FIG. **3**A is a block diagram illustrating a video client device **104***a* according to an embodiment of the present invention for use in a video network. The video client device **104***a* is essentially a simplified digital video recorder, without encoding capabilities but with communications capabilities for communication with a video server such as a digital video recorder **102***a*.

Referring to FIG. **3**A, the video client device **104***a* may operate in conjunction with the digital video recorder **102***a* as illustrated in FIG. **2**. The video client device **104***a* includes a communications interface **302**, input switches **304**, a controller **306**, a storage unit **308**, a memory **310**, an output module **312**, a display **314**, and a speaker **316**.

According to one embodiment of the present invention, the digital video recorder **102***a* downloads video content to the video client device **104***a* via the communications interface **302** by wireless communication. The communications interface **302** is preferably a wireless communication interface such as a cellular modem, a Bluetooth interface, satellite communication interface or RF communication interface. The video encoding standard and the video encoding rate for the video content downloaded via the communications interface **302** are selected by the digital video recorder **102***a* as explained above, based upon the data transmission rate of the communication network between the digital video recorder **102***a* and the video client device **104***a*, the type of video content to be downloaded, the processing power of the video client device **104***a*, or any combination of these or other factors.

The downloaded video and audio content is in digital form and the controller **306** stores it in the storage unit **308** for immediate or future retrieval. The storage unit **308** may be any type of rewritable memory capable of storing digital data, such as flash memory, a hard disk, an optical disk (e.g., a rewritable DVD (DVD-RW), rewritable CD (CD-RW), etc. . . .) or any other rewritable data storage. The storage unit **308** may have any storage capacity, such as ranging from a few minutes to hundreds of hours. Additional information such as program guide data, title of the video content, and the like may be stored in the storage unit **308** in association with the stored video content to manage and identify the stored video content.

The input switches **304** provide means to the user to control the video client device **104***a*. The input switches **304** might include, but are not limited to, a play button, a stop button, a menu button, an enter/select button, a forward button, a rewind button, a power on/off button, a standby mode button, and the like. The input commands generated by the input switches **304** are provided to the controller **306** for control of the operation of the video client device **104***a* in response to the input commands.

The controller **306** receives the various input commands from the input switches **304** and also executes instructions or programs stored in the memory **310** to control the various elements in the video client device **104***a*, including the communications interface **302**, the input switches **304**, the storage unit **308**, the memory **310**, the output module **312**, the display **314**, and the speaker **316**. The memory **310** operates as a working memory for the controller **306** when the controller **306** executes instructions and programs and may also store additional instructions such as boot-up sequences or other information. The memory **310** is preferably a rewritable memory but might alternatively be write-once memory or other types of memory.

The output module **312** includes a video decoder **318** and an audio decoder **320**. The video decoder **318** and the audio decoder **320** convert the digital video and digital audio content stored in the storage unit **308** into a format compatible with a conventional display device **314** and with a conventional speaker **316**, respectively. The video decoder **318** and the audio decoder **320** are preferably configured such that they are capable of decoding video content encoded according to any video encoding standard and any video encoding rate. The display device **314** can be a liquid crystal display (LCD) or a cathode ray tube (CRT). Other types of displays might alternatively be used.

The video client device **104***a* may be a portable device that operates as a client device to the digital video recorder **102***a*. The video client device **104***a* downloads video content from the digital video recorder **102***a* and stores it in the storage module **308** for immediate or figure retrieval. The video encoding standard and the video encoding rate according to which the downloaded video content is encoded are set by the digital video recorder **102***a* based upon various factors as described above, including the data transmission rate of the communication network between the digital video recorder **102***a* and the video client device **104***a*, the processing speed of the video client device **104***a*, and the type of video content to be downloaded. Therefore, the digital video recorder **102***a* might download video content to the video client device **104***a* in a way that is optimized for the capabilities of the network and the video client device **104***a*.

FIG. **3**B is a block diagram illustrating a DVD player **104***n* as the video client device according to another embodiment of the present invention for use in a video network. In this embodiment, the DVD player **104***n* may be a conventional DVD player.

Referring to FIG. **3**B, the DVD player **104***n* might include an internal system bus **352**, a processor (CPU) **354**, an internal memory (MEM) **356**, a keypad (KEY) **358**, a DVD driving mechanism (DVD-DRV) **360**, a DVD controller (DVD-CONT) **362**, a video decoder (Video-DEC) **366**, a sub-picture decoder (Sub-Picture-DEC) **368**, an audio decoder (Audio-DEC) **370**, a video mixer (MIX) **372**, an audio amplifier (AMP) **374**, a decrypter **364**, a display **376**, a speaker **380**, a composite converter (COMPOS-CONV) **378**, a communications interface **390**, and a storage unit **392**. All the components except the communications interface **390** and the storage unit **392** are typical components of a conventional DVD player and operate in a conventional manner. The processor **354** is modified from its conventional DVD player function to control the communications interface **390** and the storage unit **392** so that the DVD player **104***n* can operate as a client device to the video server **102***a*. The video server **102***a* can be, for example, the video server of FIG. **2**.

The processor (CPU) **354** may control all the components in the DVD player **104***n* via the internal system bus **352**. The internal memory (MEM) **356** is a working memory for the processor **354** and stores a variety of programs such as a system control program executed by the processor **354** and stores a variety of programs such as a system control program executed by the processor **354**. The keypad (KEY) **358** is provided with various keys for controlling the DVD player **104***n*, including on/off keys, play, stop, forward, rewind, menu, enter/select, and the like.

The DVD drive mechanism (DVD-DRV) **360** drives the DVD and picks up the video data from the DVD. The DVD controller (DVD-CONT) **362** controls the DVD drive mechanism (DVD-DRV) **360** under control of the processor (CPU) **354**. The DVD controller (DVD-CONT) sends the DVD data read out of the DVD drive mechanism (DVD-DRV) **360** to the video decoder (Video-DEC) **366**, the sub-picture decoder (SUB-PICTURE-DEC) **368**, and the audio decoder (AUDIO-DEC) **370** via the DVD data dedicated signal paths **382**, **384**, **386**, and **388**. In addition, the decrypter **364** is provided on the DVD data dedicated signal path **382** to decrypt the data read out of the DVD in case they are encrypted.

The video decoder (Video-DEC) **366** extracts and decodes video data from the DVD data received from the DVD controller (DVD-CONT) **362** via the DVD data dedicated signal path **384**, and outputs decoded video data. The sub-picture decoder (SUB-PICTURE-DEC) **368** extracts and decodes sub-picture data from the DVD data received from the DVD controller (DVD-CONT) **362** via the DVD data dedicated signal path **386**, and outputs still picture data. The audio decoder (AUDIO-DEC) **370** decodes audio data from the DVD data received from the DVD controller (DVD-CONT) **362** via the DVD data dedicated signal path **388**, and outputs audio signals. The video decoder **366**, the sub-picture decoder **368**, and the audio decoder **370** are configured to be capable of decoding video content encoded according to a plurality of video encoding standards at a variety of encoding rates, so that it can decode video content downloaded from the video server **102***a* encoded according to various video encoding standards and video encoding rates selected by the video server **102***a*.

The video mixer (MIX) **372** mixes the video data decoded by the video decoder (VIDEO-DEC) **366** and the sub-picture data decoded by the sub-picture decoder (SUB-PICTURE-DEC) **368** to generate an output video for display. The audio amplifier (AMP) **374** amplifies the audio signal decoded by the audio decoder (AUDIO-DEC) **370**. The display (DISP) **370** displays the output video generated by the video mixer (MIX) **372**. The display **376** can be a cathode-ray tube (CRT) used in conventional TV receivers, a liquid crystal display, a plasma display panel, or any other type of display device. The speaker **380** produces sound corresponding to the audio signal amplified by the audio amplifier (AMP) **374**.

The DVD player **104***n* may also be used so as to provide video and audio to an external display (not shown) and an external speaker (not shown). In this case, the display **376** and the speaker **380** in the DVD player **104***n* are optional components. The composite converter (COMPOS-CONV) **378** converts the output video data generated by the video mixer (MIX) **372** into an analog format compatible with conventional displays. The technical details of the composite converter (COMPOS-CONV) **378** are well known in the art.

The DVD player **104***n* may be different from conventional DVD players in that it receives video content downloaded from the video server **102***a* via the communications interface **390** and stores it in the storage unit **392** for immediate or future retrieval. As previously described, however, it is not necessary that the DVD player **104***n* store the downloaded video content. Rather, the DVD player **104***n* might play the video content in real-time or near real-time as it is downloaded to the DVD player **104***n* but not otherwise store the video content for future playback. The communications interface **390** can be any type of wireless or wired communications interface as illustrated above, and is controlled by the controller **354**. The storage unit **392** is coupled to the communications interface **390** and the video decoder **366** and outputs the stored television signal to the video decoder **366** for decoding. The storage unit **392** can be a DRAM, SRAM, flash memory, or any other type of memory device that can store digital video data. The video decoder **366** also has selection logic (not shown) that enables the video decoder **366** to select either the DVD video data received from the decrypter **364** or the video content stored in the storage unit **392** in response to a control signal from the controller **354**.

The video encoding standard and the video encoding rate according to which the video content is encoded for downloading to the DVD player **104***n* are selected by the video server **102***a* based upon various factors as described above, including the data transmission rate of the communication channel between the video server **102***a* and the DVD player **104***n*, the processing power of the DVD player **104***n*, and the type of video content to be downloaded. Therefore, the video server **102***a* can download video content to the DVD player **104***n* at an optimum data transmission rate.

FIG. **4** is a flowchart illustrating a method of selecting a video encoding standard and a video encoding rate according to a first embodiment of the present invention. This method is carried out by a controller of the video server **102***a*, for example by the controller **208** of the digital video recorder **102***a* of FIG. **2**, to select a video encoding standard and a video encoding rate based upon the data transmission rate of the communication network between the video server **102***a* and the video client devices **104***a*, **104***n*. The method of FIG. **4** will be explained in conjunction with FIG. **1**.

Referring to FIGS. **1** and **4**, as the process begins **402**, the video server **102***a* monitors and determines **404** the data transmission protocol and rate of the communication network between the video server **102***a* and the video client devices **104***a*, **104***n*. For example, the video server **102***a* determines the transmission rate the communication network can handle, preferably in terms of bits per second. This information is reported **406** to the video server **102***a*. The video server **102***a* selects **408** a video encoding standard and a video encoding rate based upon the determined data transmission rate of the communication network. For example, the video server **102***a* might use the best quality encoding standard and highest encoding rate supported by the data transmission rate of the communication network. It is not necessary, however, that the video server **102***a* select the best quality encoding standard and highest encoding rate supported by the communication channel and/or video client device.

Once the video encoding standard and the video encoding rate are selected, the video server **102***a* transcodes **410** the video content stored therein according to the selected video encoding standard and the selected video encoding rate. Finally, the transcoded video content is downloaded **412** to the video client devices **104***a*, **104***n*. Then, the process returns to step **404** to keep monitoring the transmission rate of the communication link between the vide server and the video client device, so that the video encoding standard and rate can be adaptively selected based upon any changes.

FIG. **5** is a flowchart illustrating a method of selecting a video encoding standard and a video encoding rate according to a second embodiment of the present invention. This method is carried out by a controller of the video server **102***a*, for example, the controller **208** of the digital video recorder **102***a* of FIG. **2**, to allocate an appropriate bandwidth among a plurality of video client devices **104***a*, **104***n* coupled to a video network. The method further selects a video encoding standard and a video encoding rate based upon the allocated bandwidth. The method of FIG. **5** will be explained in conjunction with FIG. **1**.

Referring to FIGS. **1** and **5**, as the process begins **502** the video server **102***a* monitors and determines **504** the bandwidth of the communication network between the video server **102***a* and the plurality of video client devices **104***a*, **104***n*. For example, the video server **102***a* determines the transmission rate supported by the communication network. This information is then reported **508** to the video server **102***a*.

Then, the video server **102***a* allocates **510** an appropriate bandwidth for each video client device **104***a*, **104***n* connected to the video network based upon the determined bandwidth of the communication network and also selects **512** an appropriate video encoding standard and video encoding rate based upon the allocated bandwidth. For example, the video server **102***a* might allocate bandwidth equally among the video client devices **104***a*, **104***n*. In another example, the video server **102***a* might use an unequal allocation of bandwidth among the client devices **104***a*, **104***n*. Once the video server **102***a* allocates the bandwidth, it may then select the best video encoding standard and highest encoding rate supported by the respective bandwidth allocations. It is not necessary, however, that the video server **102***a* select the best video encoding standard and highest encoding rate supported by the communication network and the client devices. Other selections might be made, and other factors might affect the selection.

Once the video encoding standard and the video encoding rate are selected, the video server **102***a* transcodes **514** video content stored therein according to the selected video encoding standard and the video encoding rate. Finally, the transcoded video content is downloaded **516** to the video client devices **104***a*, **104***n*. Then, the process returns to step **504** to keep monitoring the bandwidth of the communication link between the video server and the video client device, so that the video encoding standard and rate can be adaptively selected based upon constant monitoring and allocation of the bandwidth of the communication link. Since the video content is transcoded according to a video encoding standard and a video encoding rate compatible with the bandwidth allocated to a plurality of video client devices coupled to a video network, video content can be simultaneously downloaded to the plurality of video client devices.

FIG. **6** is a flowchart illustrating a method of selecting a video encoding standard and video encoding rate according to a third embodiment of the present invention. This method is carried out by the video server **102***a*, for example, by the controller **208** of the digital video recorder **102***a* in FIG. **2** to select an appropriate video encoding standard and video encoding rate based upon the processing capability of the video client devices **104***a*, **104***n* coupled to the video network. The method of FIG. **6** will be explained in conjunction with FIG. **1**.

Referring to FIGS. **1** and **6**, as the process begins **602**, the video server **102***a* monitors and determines **604** the processing capabilities, including the processing speed and the buffer size, of the video client devices **104***a*, **104***n* coupled to a video network. For example, the video server **102***a* determines the encoding rate that the video client devices **104***a*, **104***n* can handle and decode using its processor, for example the controller **306** of FIG. **3**A or the CPU **354** of FIG. **3**B. This information is then reported **605** to the video server **102***a*. The manner in which the processing capability of the video client device is determined is well known in the art.

Then, the video server **102***a* adaptively selects **606** a video encoding standard and a video encoding rate compatible with the processing capability of the video client devices **104***a*, **104***n*. For example, if the video client devices **104***a*, **104***n* do not have the processing speed to decode video content encoded at encoding rates higher than 2 Mbps, the video server **102***a* might selects the MPEG-1 standard since it does not require an encoding rate higher than 2 Mbps. Accordingly, a video encoding rate consistent with MPEG-1, such as 1.25 Mbps, might be selected as the encoding rate. On the other hand, if the video client devices **104***a*, **104***n* have processing speed to decode video content encoded at encoding rates of up to 16 Mbps, the video server **102***a* might select MPEG-2 that uses rates of 4-16 Mbps.

Once the video encoding standard and the video encoding rate are selected, the video server **102***a* transcodes **608** video content stored therein according to the selected video encoding standard and the video client devices **104***a*, **104***n*. Then, the process returns to step **604** to keep monitoring the processing capability of the video client devices, so that the video encoding standard and rate can be adaptively selected based upon constant monitoring of such processing capabilities. Since the video content is adaptively transcoded according to a video encoding standard and a video encoding rate compatible with the processing capabilities of the video client device coupled to the video network, video content can be downloaded to the video client device in a format that is compatible with the video client device but still effectively utilizes the client device's available resources.

FIG. **7** is a flowchart illustrating a method of selecting a video encoding standard and a video encoding rate according to a fourth embodiment of the present invention. This method is carried out by the video server **102***a*, for example the controller **208** of the digital video recorder **102***a* of FIG. **2**, to select an appropriate video encoding standard and video encoding rate based upon the type of video content to be downloaded to the video client devices **104***a*, **104***n*. The method of FIG. **7** will be explained in conjunction with FIG. **1**.

Referring to FIGS. **1** and **7**, as the process begins **702**, the video server **102***a* monitors and determines **704** the type of video content to be downloaded to the video client devices **104***a*, **104***n* coupled to the video network.

Then, the video server **102***a* selects **706** a video encoding standard and a video encoding rate appropriate for the type of the video content. For example, if the type of video content to be downloaded to the video client devices **104***a*, **104***n* requires high-quality images such as animation, the video server **102***a* selects a video encoding standard and a video encoding rate that delivers higher quality images compatible with the type of such video content. On the other hand, if the type of video content does not require high-quality images, such as recordings of concerts, the video server **102***a* selects a lower quality video encoding standard and video encoding rate that can deliver acceptable quality images. In this manner, the digital video recorder **102***a* can save bandwidth when dealing with a plurality of video client devices **104***a*, **104***n*.

Once the video encoding standard and the video encoding rate are selected, the video server **102***a* transcodes **708** video content stored therein according to the selected video encoding standard and the video encoding rate. Finally, the transcoded video content is downloaded **710** to the video client devices **104***a*, **104***n*. Then, the process returns to step **704** to keep monitoring the type of video content, so that the video encoding standard and rate can be adaptively selected based upon constant monitoring of the type of the video content. Since the video content is adaptively transcoded according to a video encoding standard and a video encoding rate compatible with the type of video content to be downloaded, the video content can be downloaded to the video client devices in a format that maintains the quality of the video content while still saving bandwidth in the transmission over the video network.

Although the present invention has been described above with respect to several embodiments, various modifications can be made within the scope of the present invention. For example, the method described in FIGS. **4-7** can be used independently within the video server or two or more of the methods can be combined to result in a more efficient method of downloading video content to video client devices coupled to a video network. More specifically, a method could consider both the video content being transmitted and the communication channel bandwidth in selecting a video encoding standard. In addition, the methods described in FIGS. **4-7** can be used with both wireless and wired communication networks. The present invention can be used with video networks using any type of wireless communication standards or with any wired communications standards. The present invention can also be used with any type of digital video encoding standard. The video client devices can have more intelligence than described above, such that the entire methods of FIGS. **4-7** or at least part of the methods can be carried out in the video client devices rather than in the video server. In addition, the video server and the video client device are not limited to those described in FIGS. **2**, **3**A, and **3**B, but can be any type of digital video device that has similar capabilities. Accordingly, the disclosure of the present invention is intended to be illustrative, but not limiting, of the scope of the invention, which is set forth in the following claims.

It should be understood that the programs, processes, methods and apparatus described herein are not related or limited to any particular type of computer or network apparatus (hardware or software), unless indicated otherwise. Various types of general purpose or specialized computer apparatus may be used with or perform operations in accordance with the teachings described herein. While various elements of the preferred embodiments have been described as being implemented in software, in other embodiments hardware or firmware implementations may alternatively be used, and vice-versa.

In view of the wide variety of embodiments to which the principles of the present invention can be applied, it should be understood that the illustrated embodiments are exemplary only, and should not be taken as limiting the scope of the present invention. For example, the steps of the flow diagrams may be taken in sequences other than those described, and more, fewer or other elements may be used in the block diagrams. The claims should not be read as limited to the described order or elements unless stated to that effect.

In addition, use of the term "means" in any claim is intended to invoke 35 U.S.C. §112, paragraph 6, and any claim without the word "means" is not so intended. Therefore, all embodiments that come within the scope and spirit of the following claims and equivalents thereto are claimed as the invention.

I claim:

1. A digital video recorder for transferring video content to a client device over a communication network, comprising:

a storage unit for storing the video content;

a communications interface for transmitting the video content to the client device over the communication network;

a controller coupled to the storage unit and the communications interface, wherein the controller determines, during transmission of the video content to the client device, a supportable transmission rate of the communication network and then adaptively selects an encoding standard and selects an encoding rate according to the determined supportable transmission rate of the communications network; and

a transcoder, coupled to the controller, the storage unit, and the communications interface for transcoding the video content from a first encoding standard and a first encoding rate to the selected encoding standard and the selected encoding rate during the transmission of the video content to the client device according to the adaptively selected encoding standard and encoding rate;

wherein the selected encoding standard and selected encoding rate is determined according to an allocation of the supportable transmission rate between the client device and at least one other client device.

2. The digital video recorder of claim **1**, wherein the selected encoding standard is further selected based on a type of the images depicted in the video content.

3. The digital video recorder of claim **1**, wherein the selected encoding rate is further selected based on the video content.

4. The digital video recorder of claim **1**, wherein the allocation of the supportable transmission rate is unevenly allocated between the client device and the at least one other client device.

5. The digital video recorder of claim **1**, wherein the communication network is a wireless communication network.

6. A system for transmitting video content over a communication network, comprising:

a communications interface for transmitting the video content over the communication network; and

a controller coupled to the memory and the communications interface, wherein the controller determines, during transmission of the video content over the communications network, a supportable transmission rate of the communication network and then adaptively selects an encoding standard according to the supportable transmission rate of the communications network; and

a transcoder, coupled to the memory, the controller, and the communications interface, for transcoding the video content from a first encoding standard to the selected encoding standard during the transmission of the video content to a plurality of client devices according to the adaptively selected encoding standard and encoding rate;

wherein the encoding standard is selected based on an allocation of the supportable transmission rate among the plurality of client devices.

7. The system of claim **6**, wherein the system comprises a the plurality of client devices and wherein the system further transmits the video content to at least one of the plurality of client devices via the communications interface.

8. The system of claim **7**, wherein the communications interface transmits the video content transcoded to the selected encoding standard to at least one of the plurality of client devices and transmits the video content transcoded to a second selected encoding standard to another of the plurality of client devices.

9. The system of claim **8**, further comprising a transrater, coupled to the controller, for altering an encoding rate of the transcoder based on a change in the supportable transmission rate of the communication network.

10. The system of claim **6**, wherein the selected encoding standard is further selected based on a type of the images presented depicted in the video content.

11. The system of claim **7**, wherein the encoding standard is further selected based on a processing speed of the at least one of the plurality of client devices.

12. The system of claim **6**, wherein the allocation of the supportable transmission rate between the at least one client device of the plurality of client devices and at least one other client device of the plurality of client devices is unequal.

13. A method of transmitting video content to a video client device via a communications network, the method comprising:

during the transmission of the video content to the video client device, performing steps comprising the steps of:

determining a transmission rate of the communication network, during transmission of the video content;

adaptively selecting a video encoding standard based on the determined transmission rate of the communication network;

transcoding the video content from an initial video encoding standard to the adaptively selected video encoding standard; and

transmitting the transcoded video content to the video client device over the communications network;

wherein the selected encoding standard is determined according to an allocation of the determined transmission rate of the communication network between the video client device and at least one other video client device.

14. The method of claim **13**, further comprising:

during the transmission of the transcoded video content to the video client device, performing steps comprising the steps of:

detecting a change in the determined transmission rate of the communication network;

transrating a remaining portion of the video content that has not already been transmitted to the video client device according to the determined change in the transmission rate of the communications network; and

transmitting the transrated remaining portion of the video content to the video client device.

15. The method of claim **13**, wherein transcoding the video content comprises converting the video content from the initial video encoding standard directly to the adaptively selected video encoding standard without decoding the video content.

16. The method of claim **13**, wherein the selected video encoding standard is MPEG-1, MPEG-2 or MPEG-4.

17. The method of claim **13**, wherein the allocation of the determined transmission rate of the communication network between the video client device and at least one other video client device is unequal.

18. The method of claim **17**, wherein:

the adaptively selected video encoding standard is based on the allocation of the determined transmission rate of the communications network between the video client device and the at least one other video client device;

a second video encoding standard is adaptively selected based on the allocation of the determined transmission rate of the communications network between the video device and the at least one other video client device;

the video content further transcoded from the initial video encoding standard to the second video encoding standard; and

the video content encoded according to the second video encoding standard is transmitted to the at least one other video client device over the communications network.

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